September/October 2000

Zoogoer

Volume 29 / Number 5

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SEPTEMBER/OCTOBER 2000 VOLUME 29, NUMBER 5

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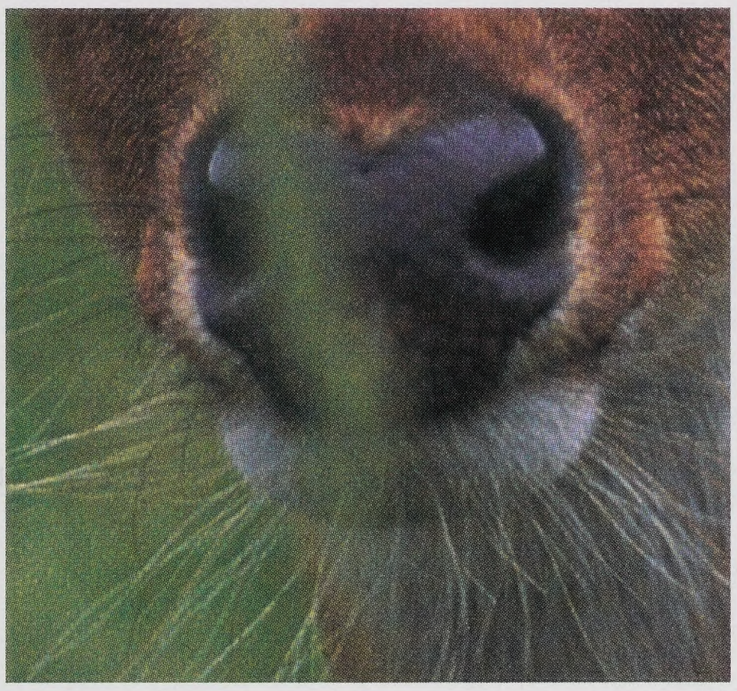

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A MESSAGE FROM THE NEW DIRECTOR

Dear FONZ members:

I am honored and excited about my new position as Zoo Director. The Smithsonian National Zoological Park is a great place. With the continued support of FONZ, I think we can be even greater.

My vision of the Zoo in the future is that it will become critically acclaimed as one of the best zoos in the world in terms of animals, facilities (for both the animals and the visitors), veterinary medicine, reproductive biology, and visitation.

We already have considerable expertise in these five areas. But if we focus our efforts and our resources, I think we can be even better. I would also like to meet the expectations of the general public who visit the Zoo: They expect to see and to learn about lions, tigers, bears, and other exciting animals. At Rock Creek, we have all of these great creatures, but many are housed in aging exhibits that are less than inspiring compared to some of our newer exhibits.

Think about the O-line and the Amazonia Science Gallery. These exhibits do more than just show people orang utans or dart-poison frogs. They catch people's attention. They inspire visitors to think about the natural world, about biodiversity. They also reflect hours of careful research into species-specific patterns of behavior, nutritional preferences, and reproductive biology. With exhibits of this quality, and the number of people who visit the Zoo each year (estimated at two million or more), we have a fantastic opportunity to be a window to the wild. In my view, this is a critical first step in fostering public support for global conservation.

Of course, to accomplish these goals we must expand our financial resources, both federal and private. We must also expand our efforts to reach out to the public—locally, nationally, and internationally.

This issue of *ZooGoer* highlights many of our Conservation and Research Center's (CRC) activities in recognition of its 25th anniversary. At CRC, we have several highly endangered species, including clouded leopards and black-footed ferrets, a group of talented researchers in reproductive biology and conservation, and a team of highly motivated educators. Yet relatively few people are aware of CRC's efforts. I hope to reveal more of these hidden talents by encouraging greater interaction between our researchers, our educators, and our animal exhibits at both Rock Creek and CRC.

As we are able to do new things for our existing collection (such as renovating the Elephant House or the bear exhibits), I would like to use the Giant Panda Exhibit Program as a model. This program includes more than new yards for the giant pandas. It also supports public education and scientific exchange (both in North America and in China) on giant pandas, collaborative research programs involving reproductive biology (both zoo and wild), habitat assessment and reserve development in China, and professional training for our Chinese colleagues. This exhibit requires expertise at every level within the Zoo, including Friends of the National Zoo.

I look forward to the future, and to working with all of you.

Sincerely,

Lucy H. Spelman, DVM
Director

Friends of the National Zoo is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the Smithsonian National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

ZooGoer [ISSN 0163-416X] is published bimonthly by Friends of the National Zoo (offices located at the Smithsonian National Zoological Park, 3001 Connecticut Ave., N.W., Washington, DC 20008-2537) to promote its aims and programs, and to provide information about FONZ activities to its members, volunteers, and others interested in the purposes of FONZ. Periodicals postage paid at Washington, D.C.

The Smithsonian National Zoological Park is located at 3001 Connecticut Ave., N.W., Washington, DC 20008-2537. Weather permitting, the Zoo is open every day except December 25. Hours: From May 1 to September 15, grounds are open from 6 a.m. to 8 p.m.; buildings, 10 a.m. to 6 p.m. From September 16 to April 30, grounds are open from 6 a.m. to 6 p.m.; buildings, 10 a.m. to 4:30 p.m.

Membership in FONZ offers many benefits: publications, discounts on shopping, programs, and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, DC 20008, or call 202.673.4961.

Membership categories and annual tax-deductible dues are:

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ZooGoer
Publisher: Clinton A. Fields
Editor: Susan Lumpkin
Associate Editor: Alex Hawes
Editorial Assistant: Sue Zwicker
Interns: Laura Zajac, Katie Venit
Contributing Editors: Robin Meadows, Howard Youth
Consulting Editor: Robert Hoage
Copy Editor: Jean B. McConville
Design: Lloyd Greenberg Design, LLC
Advertising Sales: Joyce Rains; 301.530.0583

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Cover photo: Black-footed ferret at the National Zoo's Conservation and Research Center.
Photo by Lisa H. Ware

Recycled paper

LISA H. WARE

THIS ISSUE OF *ZOOGOER* is dedicated to the Smithsonian National Zoo's Conservation and Research Center (CRC) in Front Royal, Virginia, which is celebrating its 25th anniversary this year. For a quarter century, CRC has worked to fulfill its mission to meet the "urgent need for integrated approaches that address wildlife conservation from the broad expanse of landscapes to the minute subcellular realm of genetics." The following feature articles provide but a glimpse into CRC's efforts to educate, study, and conserve.

NOTES ON NEWS

ANIMAL NEWS

The Smithsonian National Zoo celebrated the birth of three beautiful, bouncing baby beavers (*Castor canadensis*) on July 9—an event that hasn't occurred here since the Kennedy administration.

JESSIE COHEN/NZP

BEAVER AT THE ZOO.

The precocious kits, which each weighed about one pound at birth, were born with a full fur coat and open eyes and could move around the den within ten minutes. Interestingly, the kits at first couldn't leave the den because its entrance is underwater, and they were too buoyant. The kits didn't swim out of the den until they were about one month old—and heavy enough to submerge.

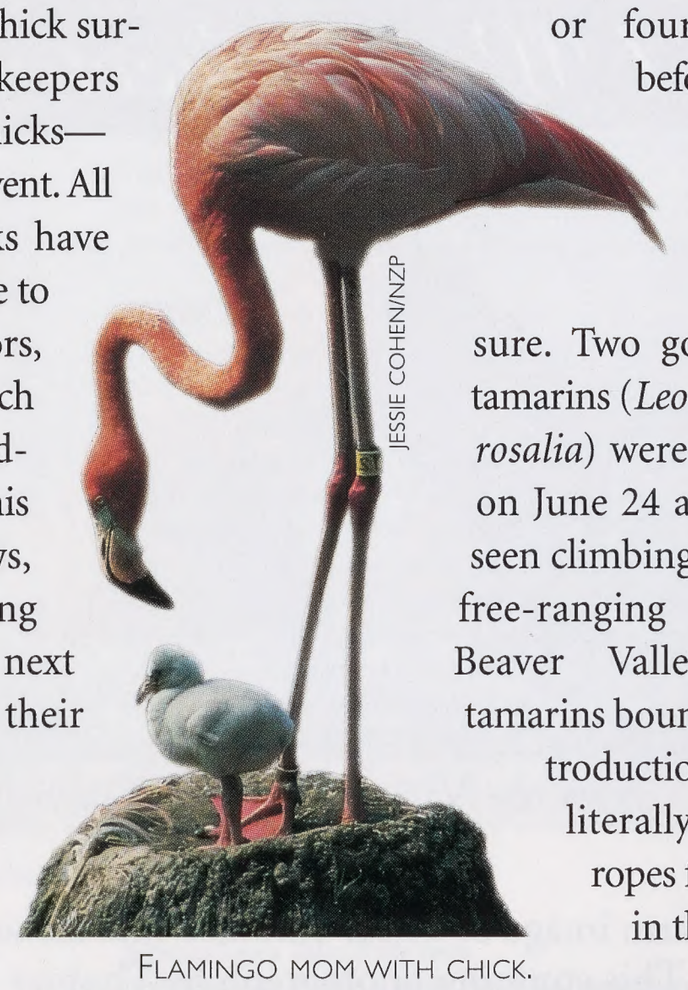
Kits usually nurse for six weeks, although they will occasionally eat solid foods while nursing. After weaning, they dine on water plants, bark, and woody stems. While this may not seem like a highly nutritious diet, adult beavers can tip the scales at 66 pounds, more than some species of deer. Beavers in zoos eat a slightly different diet. Being rodents—animals whose teeth never stop growing—they need to gnaw constantly to keep their teeth at a manageable length. This is not a problem in the wild, where beavers fell trees to construct their impressive dams and to get to the valuable young stems at the tops of trees. Because Zoo beavers don't need to fell trees for food or shelter, they are provided with chew logs to exercise their jaws and wear down their teeth. They also get rodent chow, sweet potatoes, apples, carrots, and corn-on-the-cob.

The new Zoo kits will stay with their parents for at least two years, after which they may be transferred to other zoos. Beaver parents in the wild usually push their mature kits out of the den at about that age to wander off and start their own families. Once they reach sexual maturity at three years old, beavers can breed once a year, bearing two to four kits in a litter. Wild beavers live to be 17 years old on average, but some individuals in zoos have lived 50 years.

Other momentous births were recently celebrated at the Zoo. Six American flamingos (*Phoenicopterus ruber*) hatched at the Bird House between June 15 and June 24. The amazing news is not just that they hatched, but how they are being raised. Keepers traditionally remove flamingo chicks from their large outdoor habitat and hand-rear them in a fully enclosed pen behind the scenes to protect them from native predators such as raccoons, crows, and especially black-crowned night herons. Last year, however, keepers left one of the chicks in with its parents instead of hand-rearing it. The parent-reared chick survived, so this year keepers tried it with four chicks—an unprecedented event. All four of these chicks have now grown too large to tempt most predators, having matured much faster than the hand-reared ones. With this encouraging news, keepers are thinking about leaving all of next year's chicks with their parents to be raised.

The flamingo chicks will have completely lost their downy feathers after eight to ten weeks, but they won't turn that characteristic pink color for another one or two years. The pink comes from high levels of alpha and beta carotenoid pigments found in the larval shrimp and flies that they eat as their main food source. Flamingos at the Zoo are fed pellets that contain concentrated shrimp and other nutrients.

In other egg-citing news, a red-legged seriema chick hatched in mid-June. Seriemas (*Cariama cristata*) usually have two clutches per year; this is the pair's second clutch this year. The chick will stay with its parents for three or four months before striking out on its own in another enclosure. Two golden lion tamarins (*Leontopithecus rosalia*) were also born on June 24 and can be seen climbing about the free-ranging area of Beaver Valley, where tamarins bound for reintroduction in Brazil literally learn the ropes for a future in the wild.



JESSIE COHEN/NZP

FLAMINGO MOM WITH CHICK.

FALL FANTASIA

Ever wonder what goes on out at the Zoo's Conservation and Research Center (CRC)? Come see for yourself. On October 7 and 8, CRC hosts its annual Autumn Festival, during which visitors can tour the veterinary facility, take a hay ride past exotic animals grazing in vast fields, and speak with scientists and keepers about their work. On Saturday, October 7, the Autumn Festival is open to FONZ members only, and on October 8 the event is open to the general public. For more information, call 540.635.6580. FONZ members can add on to their membership by joining the CRC Safari Club, and enjoy invitations to special events and activities as well as unique volunteer opportunities.

VISITORS ON A CRC TOUR.

FIESTA!

To celebrate Hispanic Heritage Month, FONZ will host its annual Fiesta Musical, a lively event featuring a variety of family-oriented cultural activities. Held on Saturday, September 30, and Sunday, October 1, from 11 a.m. to 5 p.m., the celebration will feature regional music, dance performances, traditional arts and crafts, hands-on kids activities, and a Latin American food court. On Sunday, a festive parade of costumed musicians and dancers will march into the Zoo, and various embassies will host booths to educate visitors on the cultural and environmental diversity of their countries. Admission to Fiesta Musical is free. Please take Metro—parking lots may be full by 10 a.m. For more information, visit www.fonz.org or call 202.673.4613.

ALEX HAWES/FONZ

JESSIE COHEN/NZP

TRICKS AND TREATS

Zoogoers beware! Ghosts, goblins, and witches, along with plenty of Pokémon characters and princesses, will fill the Zoo on October 27, 28, and 29 from 5:30 to 8:30 p.m., when Friends of the National Zoo hosts its annual Boo at the Zoo. Children under age 12, accompanied by an adult, are invited to trick-or-treat from animal house to animal house through the Zoo. Costumed volunteers will hand out candy and other goodies, and haunted trails complete with spooky music and decorations will make this event a safe way for kids to experience the thrill of Halloween. Kids will also get a chance to show off their costumes at Boo Theatre. Tickets are $8 for FONZ members, $15 for the general public; both kids and adults must have tickets for admission. Log onto www.fonz.org or call 202.673.4613 to purchase tickets or for more information.

—Katie Venit and Laura Zajac

CORRECTION: Andrew Smith ["A Rabbit Tale," p. 23, July/August *ZooGoer*] is a biologist at Arizona State University.

MULTIPLY AN
A FRONT ROYA

Rasanayagam "Rudy" Rudran is about as easy to catch as a cheetah at full sprint. "I'm sorry I didn't get back to you sooner," he tells me on the phone. "I understand you sent me an email. I was hours away from the nearest email facility."

Beyond the reach of email? Is that possible these days? It is if you're the conservation training officer for the Conservation and Research Center (CRC). Rudran's job frequently sends him to remote wilderness areas, where he concentrates on training people at the front lines of the battle to save biodiversity. Within hours of returning from a month-long trip to Uganda, however, Rudran called me to fill me in on his work.

HOWARD YOUTH

When not traveling, Rudran takes to the dewy fields of CRC, in Front Royal, Virginia, where he and his colleagues conduct scientific training as well. Like other researchers and educators at CRC, Rudran gauges his success by the number of people he helps inspire to become dedicated, effective conservationists like himself. "The most satisfying thing to me is the fact that many people out there are providing the multiplier effect," says Rudran. "Starting with one person, now there are many more people promoting wildlife conservation."

From scientific training courses to FONZ Nature Camp, CRC's 3,200 acres provide a base from which this multiplication occurs locally and globally. It is there that Rudran held his first training course 19 years ago, and where FONZ Nature Camp campers recently finished exploring field, stream, and forest. Nestled amid wild, rolling hills, CRC provides perfect habitat not only for wildlife, but for Smithsonian wildlife biologists, physiologists, veterinarians, and educators who work at the center but travel widely to share their work—whether in urban school districts or remote rainforests.

Around the World, in 80 Countries...and Virginia

Rudran had ventured to distant Uganda to lead a conservation biology and wildlife management course—the 58th workshop of its kind taught by Smithsonian Institution (SI) scientists since Rudran helped pioneer the program at CRC. His students, mostly university graduates working as park managers and wildlife biologists,

D CONQUER:
L STRATEGY

JESSIE COHEN/NZP

learned how SI scientists map and monitor park vegetation, track animals via radiotelemetry, create inventories of local biodiversity and estimate populations, observe and analyze animal behavior, develop park management strategies, and apply for research grants. Over the years, other training courses have emerged, including 11 focused on zoo biology, nine on environmental education, and others dealing with veterinary medicine and conservation genetics.

Smithsonian scientists are no longer the only trainers teaching these courses. One long-term CRC training goal is to increase the pool of alumni trainers. For example, Rudran collaborated with two Ugandan course alumni—now professors at Makerere University—to teach his latest course. Other course alumni have taught workshops in their home countries of Brazil, China, India, Malaysia, and Mongolia. By training former students to become full-fledged instructors, CRC scientists leave behind a conservation legacy in countries that are dedicated to protecting their biodiversity.

All told, more than 1,600 wildlife biologists, park managers, zoo curators and personnel, policy makers, and environmental educators from 80 countries have taken CRC training courses. Some took workshops at CRC; others received their training in their home countries, thanks to traveling Smithsonian scientists—including, in many cases, Rudran himself.

Training programs are now an integral part of CRC conservation efforts in countries such as Myanmar. There, nine training courses have been held as part of the Chatthin Wildlife Sanctuary Biodiversity Project, an ongoing collaborative research and conservation program that began in 1994. Chatthin is the last Burmese stronghold for Eld's deer (*Cervus eldii*) and its monsoon forest habitat [see following article]. Although remote, the park is ringed by 19 villages, while three sit within its boundaries. A CRC-led community relations training course assisted park managers in dealing with local conflicts over the deer and the park's other resources. Meanwhile, other training courses helped Burmese biologists perfect their research techniques, conduct ongoing collaborative research with SI scientists, and hone conservation strategies.

CRC scientists also aim to establish a chain of conservation biology centers in developing countries. These centers will serve as facilities for training and research on local and regional biodiversity, and also as community environmental education centers. SI scientists and educators, who develop the centers' curricula and teaching facilities, are helping to establish new centers in Brazil, China, Malaysia, Mongolia, Thailand, and Uganda.

In addition, CRC provides career development assistance to its most promising course alumni through matching funds for conservation-oriented projects and post-graduate education. "Some [of our alumni] have gone on to become leaders. They're now at the helm, making decisions that promote biodiversity conservation," says Rudran. Such alumni include Tirtha Man Maskey and Almamy Camara, the heads of the wildlife departments of Nepal and the Gambia, and Ullas Karanth, who left an engineering career to study and protect tigers and now manages conservation projects in India for the New York-based Wildlife Conservation Society (WCS). "Our program gave him his first formal training in wildlife conservation, from which he went on to get his Ph.D. and become a well-known conservationist," says Rudran. Other alumni include Mohammed Baakar, head of Conservation International's Africa program, Damian Rumiz, WCS's Bolivia country representative, and A.J.T. Johnsingh, Y.V. Jahala, and K. Shankar, senior scientists at the Wildlife Institute of India in Dehra Dun. Several alumni are also faculty members at leading universities

JOHN NETHERTON

BALI MYNAH (*LEUCOPSAR ROTHSCHILDI*) AND OTHER ENDANGERED SPECIES AT CRC PROVIDE RESEARCHERS AND CAMPERS ALIKE INSIGHT INTO THE CHALLENGES OF CONSERVATION.

in their home countries, helping mold the minds of the next generation of conservationists.

It all began at CRC in 1981. "We discovered that a lot of people were interested in getting training in field biology," says Chris Wemmer, the Zoo's associate director for conservation. "The course was originally given at CRC because we had the field facilities and plenty of wildlife available for study." Trainees trekked into the fields and forests to study white-tailed deer, raccoons, Virginia opossums, rodents, and songbirds. Today, CRC still hosts these training courses, while providing an important stomping ground for aspiring conservationists closer to home.

JESSIE COHEN/NZP

PRZEWALSKI'S HORSES (*EQUUS CABALLUS*) ROAM CRC'S EXPANSIVE FIELDS.

A Good Neighbor Policy

Acting locally as well as globally, CRC works closely with Virginia school districts in its own backyard. Staff members visit schools as part of community outreach programs, and teachers come to CRC for environmental education training courses based on Smithsonian research. "We try to demystify science and find ways to take the Smithsonian into the classroom," says research veterinarian Steve Monfort, who helps direct CRC's education programs. "One way is by connecting scientists directly with teachers so they can speak in the first person: 'I was with Dr. Monfort in the field when he did this,' instead of 'I read that Dr. Monfort did this.'"

LISA H. WARE

ELD'S DEER (*CERVUS ELDII*).

One such course is the Forest Biodiversity and Remote Sensing course, a three-day program that was developed by CRC's education program manager Jennifer Buff and CRC wildlife biologist Bill McShea. The course immerses local teachers in the world of conservation science. Teachers sleep at CRC by night and by day learn how to set up, measure, and map tree diversity in school biodiversity plots, and conduct statistical analyses using Smithsonian protocols. They also test hypotheses about environmental trends and interpret remote sensing images—including those of their own schools.

The two-year-old program is sponsored by the Virginia Department of Education, with additional support from the Virginia Environmental Endowment Fund. Many teachers have come away from the course inspired, offering up such rave reviews as "I enjoyed the workshop more than any I have ever attended," "Learning from such capable and experienced professionals is a joy," and "I think this program is going to revitalize our school's science program."

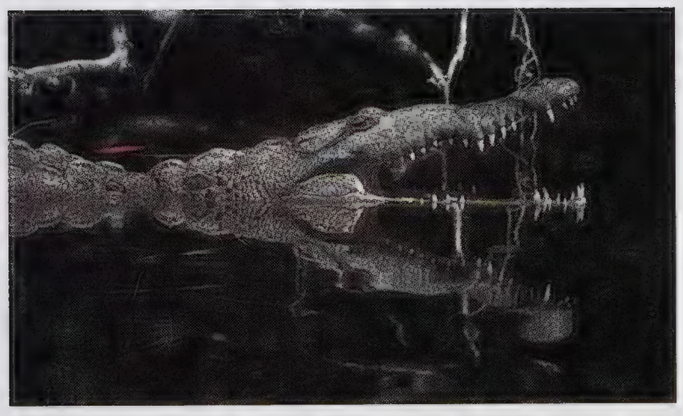
Campers, Bugs, and Bears, Oh My!

CRC's wildness and unparalleled resources also draw the younger set each summer, as FONZ Nature Camp begins. Most campers return home with memories to last a lifetime. Just ask 18-year-old naturalist-in-training Asia Hardy. This past summer, while bringing up the rear during a forest hike at CRC, she heard a snort and seconds later saw something she'll never forget. "I turned around and there was a big black bear. Luckily, he saw me and kept on going." A year before, Hardy, a Washington, D.C., resident, could barely tolerate the country life at CRC. Now she relishes her bear sighting and her time outdoors. Elena Lomicky, FONZ's CRC program specialist, has witnessed Asia's transformation. "Last year, at the beginning of camp, she was a counselor in training. She'd be very disturbed by grass, insects, and everything. Within two weeks, she was totally different—a real leader and inspiration for the kids," Lomicky says.

The FONZ Nature Camp, now in its sixth year, provides unusual opportunities for children

LISA H. WARE

SCIMITAR-HORNED ORYX (*ORYX DAMMAH*).



ALEX HAWES/FONZ

FONZ ARCHIVES

CAMPERS IN THE FONZ NATURE CAMP REVEL IN THE SITES AND SOUNDS OF THE SHENANDOAH FOOTHILLS (TOP), WHILE PARTICIPANTS IN ELIPSE CAN SEARCH FOR ALLIGATORS AND OTHER WILDLIFE IN THE FLORIDA EVERGLADES (LEFT).

interested in wildlife. "It opens their eyes to so many things," says Lomicky. "Work at the Center continues while camp is going on. We're right in the middle of a hub of world-renowned scientists, and we have access to so many resources—ponds, streams, wetlands, and forest. There's field research going on, endangered species programs, and keepers, vets, reproductive physiologists, researchers—everything is here."

Campers, fed a steady diet of hikes, campfires, and visits with researchers, seem to be spreading the word. The program has grown to embrace about 210 children per summer, spread over five weeklong sessions for nine- to 12-year-olds. It's too early to tell if any camp alumni will become the shining conservationists of tomorrow (the oldest are just entering college). Hardy might not wind up being a researcher like Rudy Rudran—she plans to pursue a journalism degree—but she and hundreds of campers will always carry a stronger appreciation for nature and conservation thanks to their weeks spent living among CRC's birds, bugs, and bears.

ELIPSE Shines in the Sunshine State

Looking like painted chickens, purple gallinules strut along the shore, careful to side-step sunning alligators. Just beneath the glassy water float four-foot-long gar, primitive, long-nosed and bodied fish. Meanwhile, on the path stands a dumbstruck group of students and teachers. Astride the Anhinga Trail in Everglades National Park, the kids find themselves a world apart from their urban neighborhood, which sits only a freeway drive away.

"Although we're in Miami and right on the Everglades, a lot of our students had never gotten out," explains Mario Castellanos, coordinator for the Environmental Latino Initiative Promoting Science Education, or ELIPSE. A joint effort between the Smithsonian, the Miami Metro Zoo, the Museum of Science, and Fairchild Tropical Gardens, the ELIPSE program links researchers to Miami/Dade County Public Schools. The goal: to promote multi-cultural participation in environmental education through mentoring, community outreach, and teacher training.

> "We try to demystify science and find ways to take the Smithsonian into the classroom."

Many of the SI scientists participating in this program work at the Smithsonian National Zoo. "This program allows us to provide outreach beyond the Mall, to under-served audiences," says CRC's Monfort, who founded ELIPSE in 1998. "For us, the idea is follow-up. We work with a small number of teachers and provide them with a lot of resources. This way, we create master teachers who become multipliers for teaching students about our scientists' research and practices."

ELIPSE now reaches eight middle schools and one high school, serving a total of about 1,600 students. "We don't force them with the curriculum," says Castellanos. "We ask, 'What are you doing and how can we be a resource?' That's how the ELIPSE program works." So far, Castellanos and SI scientists have visited classrooms and given lectures, slide shows, and demonstrations, taken students and teachers on local field trips, and helped teachers set up neighborhood plots where students and teachers grow native plants and inventory local insect, bird, and plant diversity.

The ELIPSE program rates high both among teachers and students. One high school student reports that she finalized her decision to pursue zoology after a visit and lecture given by National Zoo Amazonia Science Gallery researcher Ryan Valdez. She is now a zoology major at the University of Florida—Gainesville and will likely seek a research internship at CRC next summer.

The program can encourage students struggling with their schoolwork. "We spend a lot of time outside, and it's been an incentive the teachers have used to motivate students. Many students have changed their attitudes about school and environmental issues because of their involvement in the program," says Castellanos. Inspired students may become tomorrow's community leaders or conservationists. In this way, Castellanos's work mirrors that of the globe-trotting Rudran. They are both "multipliers" and members of the far-reaching CRC staff, which reaches out to thousands of people to help save wildlife, from the Everglades to Washington, D.C.'s, backyard and beyond. Z

—Howard Youth is a Contributing Editor to ZooGoer.

JESSIE COHEN/NZP

RADIOTELEMETRY TRAINING AT CRC.

THE THAMIN & A PLACE CALLED CHATTHIN

BY CHRISTEN WEMMER

JOHN NETHERTON

News spreads quickly in the jungle. As the sun was rising on the railway village of Chatthin, the ladies at the morning bazaar were talking about it, and soon the word spread to the village tea shops. The savory meat of *thamin*, or Eld's deer, was for sale today in the Magyi-gone marketplace.

U Myint Aung, the newly appointed park warden, also got the news. Within the hour he was heading to Magyi-gone with his staff of armed foresters. It was April, peak of the hot dry season, and a plume of dust floated behind the derelict Cvechoslovakian tractor as it chugged across the parched landscape on the edge of Chatthin Wildlife Sanctuary. Occasional bullock carts pulled aside to make way for the tractor, upon which the rag-tag staff perched like chickens on a crowded roost.

LISA H. WARE

A THAMIN, OR ELD'S DEER (*CERVUS ELDII*), AT CRC.

It didn't take long to locate the house with the deer meat, and U Myint Aung did his job. He confiscated the meat, fined the family for possession of illegal game, and promptly filed the case at the park headquarters in the village of Kanbalu.

That evening an old friend paid him a visit. He offered U Myint Aung a *pan*—betel nut, lime, and condiments wrapped in a pepper leaf. After the usual small talk, he became serious, and asked about the raid in Magyi-gone village.

"How could you make such a mistake, brother?" he asked sternly.

"What do you mean?" said U Myint Aung with surprise, "I was only doing my job!"

His friend paused to spit the red betel juice, and then looked at him solemnly. "You could have had friends in that village. If you had let them keep the meat, they would have shared it with you. They would have given you water and food when you visited. Now they will hate you. Now you will never get their help. *Ma kaung bu*, my friend, *ma kaung bu*." Not good, my friend, not good.

Such is the park warden's dilemma in Myanmar, the Southeast Asian nation known as Burma until 1989. As custodians of large and choice pieces of natural real estate, wardens are the people who protect wildlife, enforce the law, supervise the work force, and try to resolve a continuous stream of conflicts between the park and the people who live in and around it. Usually underpaid, some wardens see their post as a license for entrepreneurial activity. Others defend the law, and in doing so alienate the local people. To complicate matters, park staff usually come from local villages. To meet their needs, villagers play a cat and mouse game, with park wardens and staff trying to stop their clandestine use of the park. But harsh law enforcement creates animosity between park staff and villages, foments bitterness, and often leads to violence.

U Myint Aung (pronounced "oo mee ow") is responsible for protecting Chatthin Wildlife Sanctuary—104 square miles of second-growth *indaing* located on the northern edge of Myanmar's central plains, 125 miles northwest of the city of Mandalay. Indaing is deciduous broadleaf forest dominated by the "in" tree (*Dipterocarpus tuberculatus*), which shares the sandy soils and ancient volcanic ridges of the region with a few other species, such as *ingyin* (*Pentacme suavis*), and *thitsi*, or lacquer tree (*Melanorrhoea usitata*). A wide swath of this ecosystem once covered the shimmering floodplains of the Irrawaddy River. Wherever 40 to 80 inches of rain fell annually, similar monsoon forest cloaked large areas of Southeast Asia. Meandering creeks and small rivers link the terrestrial landscape to the giant rivers like the Irrawaddy and its westerly tributary, the Chindwin River.

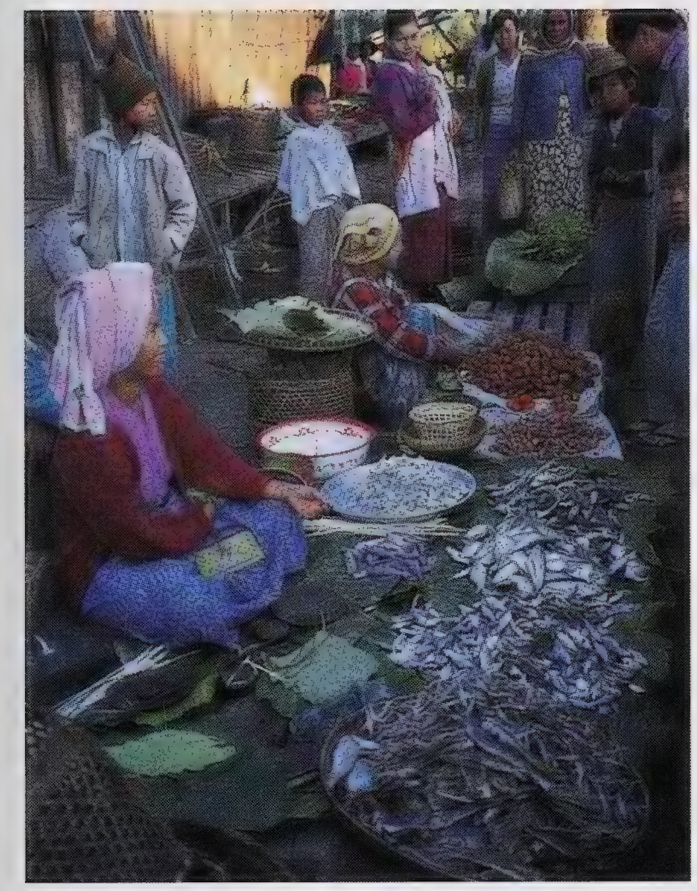
Monsoon forests are thin-canopied and grass-friendly. Dappled light reaches the grasses of the forest floor, and open grassy glades called *lwins* dot the landscape like emerald oases. Only a few decades ago these grassy forests sustained a substantial community of large charismatic mammals. Herds of wild cattle—banteng (*Bos javanicus*) and gaur (*Bos sauveli*)—moved between the lwins. Four species of deer—thamin (*Cervus eldii*), muntjac (*Muntiacus muntjac*), hog deer (*Cervus porcinus*), and sambar (*Cervus unicolor*)—partitioned the habitat according to their needs for cover and food. Sounders of wild pigs (*Sus scrofa*) rooted in the soft soils along the creeks. These large herbivores fed a guild of predators: tigers (*Panthera tigris*), leopards (*Panthera pardus*), wild dogs (*Cuon alpinus*), and pythons (*Python molurus*). Several species of scavenging birds picked over the remains of the predators' kills.

The scene started to change after World War II, when modern firearms became available to the common Burman. Shooting game animals, a popular diversion of the colonial British rulers, became a subsistence activity of poor villagers. When the Burmese socialist regime came into power in the 1960s and controlled the ownership of guns, it was too late. Most of the big game of the indaing had perished and, without food, so had most of the predators. Today, only three species of large mammals remain—the thamin, the muntjac, and the Asiatic wild dog. The thamin is highly threatened. Its last refuge is Chatthin Wildlife Sanctuary, where a population of about 1,000 deer live in the dry dipterocarp forest. It is U Mying Aung's job to protect them.

A Zoo Saga

In 1969, when there were still occasional reports of a tiger in Chatthin Wildlife Sanctuary, the Smithsonian National Zoo received its first thamin from Burma's Rangoon Zoological Gardens. From the outset, the deer proved difficult to manage. They were high strung, frequently bolted, and injured themselves by dashing against the fences.

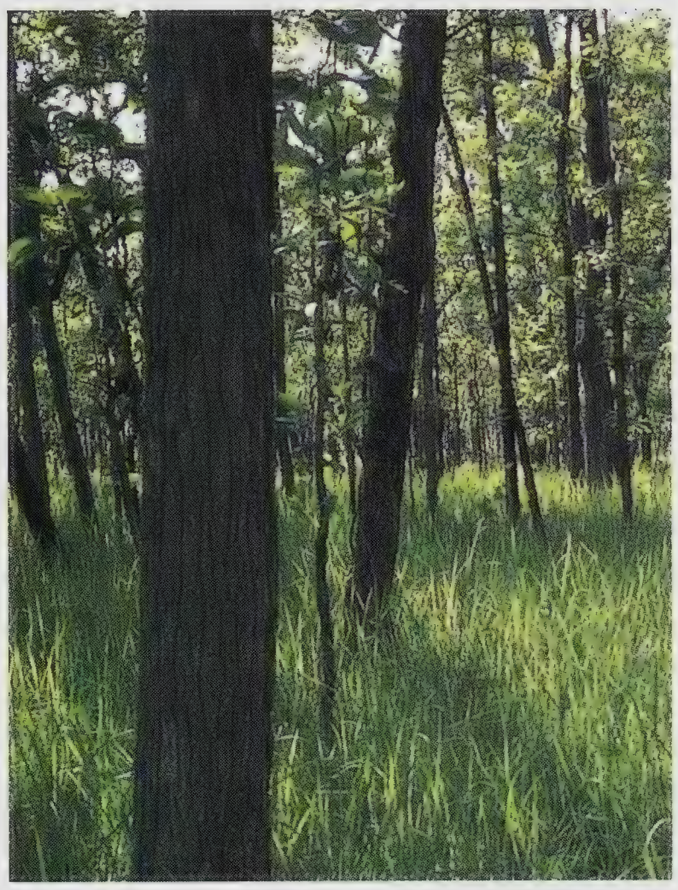
EDUCATION IS A KEY PIECE IN THE THAMIN CONSERVATION PUZZLE.



CHRISTEN WEMMER

A VILLAGE MARKET NEAR CHATTHIN WILDLIFE SANCTUARY.

COURTESY SEASIATRAVEL.COM



CHRISTEN WEMMER

INDAING MONSOON FOREST ONCE BLANKETED THE CENTRAL PLAINS OF MYANMAR.

During the rutting period, the males lost their fear of people and attacked keepers. And the birth period, in the fall and winter, was not timed to optimize the survival of fawns. But the herd grew despite these problems. By the mid-1970s, a small group of thamin was shipped to Front Royal, Virginia, where the Zoo had recently established the Conservation and Research Center. In their new 30-acre enclosure of woods and pasture, the deer became wilder than they had been in the Zoo. The keepers had trouble making daily head counts, fawns were almost impossible to find, and those that survived the winter of their birth were even more wild and wary.

We decided a more intensive form of management was needed, so we started to hand-rear thamin fawns. These tame deer were then kept at the newly completed Rivinus Barn, which was designed specifically for studies of ungulate biology. The deer had access to green pastures, but were harness-trained for routine measurements, semen collection, milking, and weighing on an electronic scale capable of measuring the change in a doe's body weight before and after nursing her fawn.

Studying the succeeding generations of thamin born at Rivinus Barn revealed many facets of the species' biology, from their relatively long gestation period of 272 days to patterns of growth and development. Research veterinarian Steven Monfort deciphered the endocrine control of the reproductive cycle, and postdoctoral fellow Sue Crissey studied lactation. After a decade and a half of study, we knew more about many facets of the thamin's biology than we did about any other species of tropical deer.

But knowledge about the deer's ecology was a glaring gap in the picture. All of the adaptations we had studied had evolved in a remote and mysterious landscape on the other side of the world. Not knowing more about thamin in the wild hindered interpretation of almost all of our Zoo findings. The timing of the birth season was a case in point. Seasonally breeding ungulates usually give birth when food is abundant and nutritious. In Southeast Asia, the monsoon season from May to September is a period of lush verdure. Yet the thamin gives birth during the cool dry season from November to February, when the grasses are turning brown and the brittle leaves are riddled with insect damage. Why? If we wanted to understand the ecology of thamin, we had to study them in the wild.

Prospecting for a field site offered a reality check. Historically, *Cervus eldii* ranged from eastern India in the west to China's Hainan Island in the east. Geographic isolation had created at least three subspecies, or races, but by the mid-1980s all three were on their way out. The largest subspecies, the marsh-loving *eldi*, is confined to a peculiar floating bog in Logtak Lake within India's Manipur State. It numbered less than a couple hundred animals. The subspecies *siamensis* once occupied the vast monsoon forests from Thailand to Hainan. It was extinct in Thailand, thinly scattered in Laos and the killing fields of Cambodia, and on the brink of extinction in Vietnam. On Hainan Island, a few hundred deer were protected in a large enclosure.

The Burmese subspecies, *thamin*, however, was estimated by United Nations biologists to be 2,200 strong on the wooded plains. What's more, two wildlife sanctuaries had been designated as refuges for thamin, and one of them, Chatthin Wildlife Sanctuary, harbored a population estimated in four figures. This seemed to offer the best site for an ecological study.

Yet Burma was a troubled land, largely forgotten by the modern Western world. The time warp was apparent in 1988 when we boarded the

CHRISTEN WEMMER

> Most of the big game of the indaing had perished and, without food, so had most of the predators.

Burma Airways flight in Bangkok. The plane was a Fokker of classical vintage, and a diverse assemblage of dead insects rested in the spaces between the windows and in the overhead lights of the cabin. I was less interested in the kinds of insects than how they became entombed in the plane's parts. As it accelerated down the runway and started to shimmy, my question was answered. All the panels and seats squeaked and rattled. The parts were all loose; the plane was porous.

In Rangoon, U.S. Agency for International Development (USAID) officials whisked us through customs and immigration, and drove us to a private residence in the suburbs. Fragipani flowers scented the balmy night sweetly, but the city looked haggard and was as still as a ghost town. Our visas gave us only a week to make contact with Burmese colleagues and attempt to arrange a study. It soon became apparent that pursuing field studies would be an elusive goal, and for some reason the university was out of bounds. But the director of the Rangoon Zoo was anxious to host a training course in zoo biology and USAID was willing to cover the costs. The zoo had a large collection of thamin, so there were still possibilities for studying the deer in their native land.

But all of our hopes were dashed a few weeks later when we were back home in the states. The democratic movement had clashed with the socialist regime, and university students were shot in the streets. When the National League for Democracy won the elections a year later, the 26-year-old socialist regime, backed by the military, seized power from the newly elected leaders. Against this human drama, studies of thamin ecology seemed not only beyond our grasp, but trite. We set aside our plans for six long years.

CHRISTEN WEMMER

Fast Forward

"*Yaaay yahmay, yaaay yahmay.*" An army of chanting women vendors circled us and searched our faces for interest in a cup of cool water, or a wayfarer's snack of green mango with pepper, rice cakes, or fermented beans. It was late 1994 and we were back in Myanmar—the country had been renamed in the interim—at one of the many whistle stops on the 1,000-mile Rangoon (renamed Yangon)-to-Myitkyina railway that ran north nearly the full length of the country. We were bound for Chatthin Wildlife Sanctuary on the Engineer's Motor Carriage, a diesel-powered sardine can-on-wheels that could reach a shuddering 40 miles per hour where the track was safe, and poked along at a snail's pace where it was not. My colleagues were three ornithologists, the National Zoo's John Rappole, the National Museum of Natural History's Pam Rasmussen, and the talented young bird artist John Anderton. We were on our way to present a training course on bird survey methods at the last stronghold of the thamin.

The Wildlife and Forestry officials had expressed several of their needs at a workshop held two years earlier in Yangon. First and foremost, they needed in-service training for the staff of the wildlife division. As one official put it, "Few of the new generation have an education equal to their responsibilities. You see, English-medium studies were abolished during the socialist period. Our young staff has not had the educational privilege we enjoyed." Second, there was a need for basic biological surveys. Myanmar's biological diversity had never been thoroughly inventoried. And third, there were serious challenges to conserving some of Myanmar's premier species, including Asian elephants (*Elephas maximus*), tigers, and thamin. Our original goal—to study the ecology of the thamin—had to be expanded to include conducting biodiversity surveys and offering professional in-service training.

The bird survey course served as our long-awaited introduction to the people and setting. Chatthin Wildlife Sanctuary, we learned, was not a wild and verdant landscape. The British had set the area aside in 1918 as a fuel-wood reserve for the steam engines that plied the railway. The railway attracted settlers, and wayside villages popped up. The timber camps within the park were never disbanded, and three of them grew into villages. During the economic slump of 1986 many of the railway villages uprooted and relocated on the park's boundary to be closer to firewood and timber. Today, the sanctuary is surrounded by a patchwork of rice paddy that sustains 19 villages and nearly 2,000 households.

In spite of assurances to the contrary, we found that the facilities at the sanctuary needed a few improvements. There were no utilities, no running water, and no paved roads. Deeply rutted cart tracks marred the dusty landscape. An antiquated tractor was the only vehicle available for long-distance transportation within the park. The camp generator was about to die, and the limited supply of florescent lights had to be moved and re-wired wherever needed. (Over the dining table they attracted a swarm of insects. The fallout was overwhelming. You ate fast. If you didn't, a mole cricket would go down your shirt, or a flying dung beetle would practically knock you off your chair.)

But the basics were there—a small bungalow for guests, a dirt-floored cookhouse, two clapboard dormitories for staff and trainees, and an open-sided, dirt-floored classroom. The most modern structure was a large cement-floored

JOHN SEIDENSTICKER

HERDS OF GAUR (*BOS SAUVELI*) AND MANY OTHER LARGE MAMMALS HAVE DISAPPEARED FROM CHATTHIN SINCE WORLD WAR II.

mess hall; a year later it was converted to a natural history museum to house the biodiversity collections and to teach local children.

The wildlife staff who attended the course were enthusiastic and devoted, but there was a language problem. We had asked about translation of our lectures into Burmese, but the wildlife officials had assured us that nearly everyone could "understand English—more or less." The students took notes in Burmese, but sometimes their eyes seemed to glaze over. And when we asked questions, they strained to understand. "How many of you understood everything U John said?" I finally asked. One hand was raised. "How many of you understood half of what he said?" A few more hands went up. "How many understood a little bit?" After a bit of subdued banter, almost everyone grinned and raised their hands. Later, we learned that the entire class met clandestinely every night for mutual tutoring and drilling.

The two-week-long course was a success. The wildlife staff was hungry for knowledge and willing to work. We also found that conditions in Chatthin were amenable to a field study. We knew we could make a difference, so we gamely started the project to study the ecology of thamin and to plan a series of training courses in biodiversity.

The wildlife director selected U Myint Aung, an ever-smiling member of the wildlife staff, to become the project's principal investigator. In his late thirties, he had leadership, field experience, and a reputation for getting results. Within a year he was promoted to park warden. Our goal, as mentors, was to see that he orchestrated research worthy of earning a master's degree and suitable for publication in scientific journals. He selected the thamin project team of six young men and women, and CRC ecologist Bill McShea and veterinarian Steve Monfort trained them to capture, anesthetize, and radio-collar deer. During the next five years, Aung coordinated the day-to-day activities of the team, made all local arrangements for the ten training courses delivered by Smithsonian Institution personnel, and handled a range of local problems with diplomacy and skill.

The team captured and radio-collared 11 male and eight female thamin, spent thousands of hours in the field, and sighted wild deer nearly 1,000 times. We learned that the thamin's life cycle was finely tuned to the seasonal rhythm of its environment. With an average group size of 2.5 deer, mother with young seems to be the basic social unit. Males form bachelor groups when their antlers are in velvet. When new grass sprouts in the ashes of February and March fires, large numbers of deer converge to graze on tender shoots. Bachelor groups and large prime males then move through the herds seeking receptive females. In spite of the seasonal changes in group size, each male and female uses a distinctive home range of about 3.5 and 2.7 square miles respectively, which is surprisingly large compared to other species of tropical Asian deer. Home ranges overlap and expand in the hot dry season, when forage is low in food value. Some animals migrate into farmland for a few months before

CARL C. HANSEN

TRAINING COURSE PARTICIPANTS AT CHATTHIN EXAMINE INSECT COLLECTIONS.

returning to the park. By day, they hide themselves in small patches of degraded forest; at night, they make forays into the croplands.

In the hot dry months of March and April, males reach the height of rut. With their newly hardened antlers, males enter a period of anorexia and sexual obsession. They spend their time seeking and competing for receptive females. Does give birth in the cool dry months of November and December, as in the Zoo. Though the vegetation has passed its nutritional peak, we learned that this isn't an unfavorable time for birth. The does are fat from feeding during the monsoon, the ground is dry, and there is still plenty of cover for fawns to hide. By the time fawns are foraging and able to flee predators, the fires have ushered in green pastures of tender grasses. It seems that the steamy, wet conditions of the monsoon pose greater risks to fawn survival than could be offset by the advantages of abundant nutritious food. Drowning would be a danger because monsoon rains literally transform the landscape—small creeks overflow their banks, and more than half of the park becomes waterlogged. Escaping from predators is more difficult in the wet conditions. The air hums with biting insects, and the damp earth is ideal for fostering infections.

We rarely detected predation but of eight thamin that disappeared, four fell prey to wild dogs. The small red dogs eluded our attempts to study them, and even a professional trapper was unable to catch any. All signs of the animals' presence—scats and tell-tale carcasses of prey—disappeared after about a year. We now believe that this predator must range over a vast area to find thinly distributed thamin and other prey such as muntjacs.

Ironically, even in the absence of major predators, Chatthin's thamin population isn't increasing. We found no evidence that an annual surplus of yearling males seeds adjacent areas, as happens with other deer populations. Which raises the question, is the thamin's future secure elsewhere in the indaing? In 1997, U Myint Aung deployed a survey team to 24 townships throughout the country's central plains to find out. The survey revealed that thamin and suitable patches of habitat remained in 23 townships. But there was an alarming 60-percent decline in the deer's range from 1978 when the first survey was conducted.

There was no correlation between number of thamin and amount of forest, size of human population, or size of livestock population. Peter Leimgruber, of World Resources Institute, analyzed satellite images of the 47,500 square miles of remaining indaing in Myanmar, an area roughly the size of Pennsylvania. He found that the size of the forest fragment was the only landscape feature that predicted the presence of thamin. Thamin disappear when a patch of indaing is smaller than about ten square miles. The landscape analysis tells us that only 14 out of 411 stands of forest were large enough to support thamin. Chatthin is the largest, and one of only two protected areas harboring the species.

The Missing Piece

After four years of daily field work, various parts of the ecological puzzle had fallen into place. More than two dozen Smithsonian Institution scientists had visited Chatthin Wildlife Sanctuary. The emerging picture of the ecosystem was the composite view of these diverse specialists, and we were growing confident that we understood the seasonal ebb and flow of the system. But the puzzle wasn't complete. We weren't privy to the human dimension. Like a kind parent, U Myint Aung sheltered us from distractions to our work. Unless you probed, he minimized problems. The Burmese have a word for it—*ah-na-day*. It means sparing your friend discomfort or embarrassment, not being blunt and discourteous.

But it turns out there were problems in this bucolic setting. The park is full of resources people needed. Villagers coveted the park's timber to build homes. They needed firewood for cooking. They used forest products such as medicinal plants for their everyday subsistence, and, of course, they wanted thamin meat to eat. In protecting the park, staff denied the villagers these essentials. So the villagers took what they could get away with. Sometimes they were caught.

U Myint Aung enforced the law, but there was a price to pay. One day, I noticed that his wife wasn't her normal cheerful self. That night I asked him if she was ill. He explained.

"She is not sick, only unhappy. She has lost friends. They no longer talk to her because I do my job."

"Why did her friends stop talking to her?" I prodded.

"Oh, there are many problems in Chatthin Wildlife Sanctuary!" he laughed, and then he told me the story.

The recent construction of a distillery in Kanbalu had created a market for a lucrative cash crop—sugarcane. The villagers' problem was finding land to grow the new crop. Most available land was planted in rice, and converting rice paddy to sugarcane fields was not an option in this subsistence economy. So the villagers took a chance. They entered the sanctuary, cut 1,000 acres of mature indaing, and planted sugarcane. A settlement of 52 huts had already sprung up when the park staff discovered the encroachment.

U Myint Aung consulted with headquarters and then posted official notice in the villages around the park: The villagers would be allowed to harvest the illegally planted crop, but the Wildlife Division would take immediate action to evict the settlers. An eviction date for the settlement was announced, and villagers were alerted to remove all valuables from the encroachment before that date. On the fateful day there was a standoff. Village men were at the ready with their *dahs*, or long knives, and women were sobbing. The crowd retreated only after 16 guards fired rounds into the air. Then the huts were torched.

"Now some villagers want to kill me," he continued. "My wife is very worried. About two

CHRISTEN WEMMER

TIMBER AWAITS SHIPMENT BY RAIL TO THE CAPITAL, YANGON.

months ago, I gave my staff strict orders: Do not speak to my wife about problems in Chatthin Wildlife Sanctuary."

It finally dawned on us. The biggest piece missing from the puzzle was human ecology. So in 1999 we started a new chapter in the thamin project. Teri Allendorf, a University of Minnesota conservation biologist, Chris Duncan, a Smithsonian Institution anthropologist, and National Zoo associate director David Jenkins conducted the first community relations workshop. Following the workshop, two survey teams started to visit the park's 22 neighboring villages. Their goal was to become familiar with farming and land-use practices, and to assess attitudes toward the sanctuary. A third team surveyed vendors in Chatthin's market to determine how many forest products are being used in this subsistence economy. Finally, Jenkins worked with the park staff to convert the education center in Chatthin village into a gathering place for local teachers, children, and sanctuary educators.

It finally dawned on us. The biggest piece missing from the puzzle was human ecology.

The process in itself was constructive. It gave the surrounding communities a chance to air their views. We learned that villages differ in their perceptions of the problems and benefits of the sanctuary, depending on where the villages were located relative to the park. All want access to forest products, with fuel wood and house poles the most coveted items. Villages embedded in the sanctuary have the most positive perceptions of the park. While outlying villages make do with sticks and bamboo to build their fences, these villagers use park logs that qualify as top-grade house poles. Satellite maps clearly show the spreading impact of such use: a large, yellow, amoeba-shaped zone in the sanctuary's green heart.

JOHN SEIDENSTICKER

THE SAMBAR (*CERVUS UNICOLOR*) IS NOW EXTINCT IN CHATTHIN.

Surprisingly, the thamin and the "good climate" created by forest are regarded nearly everywhere as benefits of the sanctuary. However, thamin are a major nuisance in southern villages, where they eat crops, and in the northwest region the reclaimed piece of the sanctuary is still a bone of contention.

The survival of the thamin and the welfare of local people depend on the very same landscape—Chatthin Wildlife Sanctuary. The human dimension is now beginning to play into this conservation story. It won't be easy to solve the problems, but studying them was the first step. New policies and land-use practices will be needed next. Integrating community development and wildlife conservation is an experiment with an uncertain outcome, and resolving conflicts between people and parks is difficult anywhere in the world. But it simply must be done.

No one imagined this turn of events 30 years ago when the first thamin arrived at the National Zoo. The thamin work has been an odyssey of discovery. Our Burmese colleagues have learned the importance of science, and we learned about conservation in a remote corner of the world. It has also been an opportunity for the National Zoo to share a commitment and affect the future of wildlife. We believe that zoos must be windows on the natural world. Our obligation to the public is to do the right thing—to ensure that the view from the window holds promise for a future with wildlife.

—Christen Wemmer is the National Zoo's associate director for conservation and head of the Zoo's Conservation and Research Center.

BY ALEX HAWES

Conservation at the close of the 20th century:

A woman in lime-green scrubs, face muffled behind a white, paper mask, leans over an anesthetized black-footed ferret. The ferret's slender abdomen has been shaved and sterilized with a butterscotch layer of Betadine, then distended slightly by air pumped through a tiny orange hose. A sharp antiseptic odor pierces the room.

PHOTOGRAPHS BY
JESSIE COHEN/NZP

ZOO STAFF HOLD TWO BABY BLACK-FOOTED FERRETS BORN THROUGH ASSISTED REPRODUCTION.

Black-Footed Ferrets: LIFE BEHIND THE MASK

WILDLIFE BIOLOGISTS RELEASING FERRETS BORN AT CRC INTO ARIZONA'S AUBREY VALLEY.

Bluebelle—one of only 520 black-footed ferrets left on the planet—has just been inseminated.

The surgeon—JoGayle Howard, reproductive physiologist at the Smithsonian National Zoo—inserts a small metal laparoscope into the creature's swollen abdominal cavity, while a camera mounted on the scope's tip relays an image to a monitor positioned at the foot of the operating table. The picture shifts and zooms across a tangle of organs before finally focusing on two conjoining, pink tubes: the ferret's uterus. Having received a hormone injection 24 hours earlier, the animal should just now be ovulating. Howard threads a 25-gauge catheter—narrower than the needles used to draw blood from humans, but appearing as large as a crowbar on the screen—through the patient's skin and into one horn of the uterus. Satisfied with the needle's position near the ovary, Howard pipettes 100 microliters of cloudy solution into the uterus, then removes the catheter and repeats the procedure with the other horn. Bluebelle—one of only 520 black-footed ferrets left on the planet—has just been inseminated.

Forty-one days later, the laboratory matchmaking bears fruit as five of Bluebelle's white-furred babies emerge from the womb. The kits scramble blindly around their mom for the next month—nursing, sleeping, nursing, sleeping—before their eyes finally open.

The ferret population is now one percent larger.

To the casual observer, artificial insemination (AI) may appear intrusive, if not downright rude. But as black-footed ferrets (*Mustela nigripes*) rally from the very brink of extinction, there's little time for romance. The Smithsonian National Zoo's Conservation and Research Center (CRC) and other organizations have mounted a monumental campaign to save the ferret, one of the most endangered mammals in all of North America. The effort involves not just natural and assisted reproduction of ferrets in zoos and conservation breeding facilities, but training ferrets for a future back in the wild. Colony by colony, state by state, ferrets are slowly returning to their western haunts, inspiring hope for a restoration of the wild America that early European explorers encountered—and later settlers nearly extinguished.

Little Room on the Prairie

Black-footed ferrets belong to the Mustelid family, a group of 64 musk-producing species of carnivore that includes badgers, wolverines, otters, and weasels. Ferrets' powerful jaws—characteristic of mustelids—are adapted for the swift submission of prairie dogs, as well as the occasional mouse, ground squirrel, or bird. Their limber frames allow them to dart through bending burrow tunnels and brace against tunnel walls for leverage when seizing prey that often outweighs them. To fuel high metabolic rates, adult ferrets must eat a prairie dog every three to four days on average to survive.

A half-million or more black-footed ferrets once inhabited wide swaths of the North American grasslands, which stretched unbroken from southern

FERRET BOUND FOR RELEASE BOARDING FLIGHT IN SELIGMAN, ARIZONA.

BLACK-FOOTED FERRET POPULATIONS ARE SLOWLY RETURNING TO THE GRASSLANDS OF THE WESTERN GREAT PLAINS.

Canada across the western Great Plains to northern Mexico. Until the arrival of white settlers, an estimated one quarter of this vast landscape—more than 100 million acres—was pocked with prairie dog (*Cynomys* sp.) burrows channeled deep into the soil in a maze of tunnels and chambers. The largest prairie dog complex, in Texas, measured 100 miles long and 250 miles wide (more than twice the size of Maryland) and contained perhaps 400 million prairie dogs by one estimate. Ferrets slept, hid, mated, and gave birth in these burrows, and prairie dog meat formed 90 percent of their diet.

Lewis and Clark reported an "infinite number" of prairie dogs during their journey west at the beginning of the 19th century. The explorers didn't make note of any black-footed ferrets, however—although these lithe hunters were likely lurking below ground, awaiting nightfall. John James Audubon and his naturalist sidekick, the Reverend John Bachman, officially "discovered" the black-footed ferret in 1851 when a fur trader forwarded them a pelt with the distinctive ivory and brown markings, black feet, and black-tipped tail from an outpost along the lower Platte River in Montana. No other ferret sighting or specimen was reported for 25 more years, and rumors spread that Aubudon and Bachman faked the discovery to bolster their landmark book, *The Quadrupeds of North America.*

Of course, Plains Indians already knew the black-footed ferret well, referring to the masked creatures as *pispiza etopta sapa*, or "black-faced prairie dogs," and using their pelts to adorn ceremonial outfits. But just as indigenous Amerindians were displaced by European colonists, so too were ferrets and their prairie dog prey. More than 98 percent of prairie dog habitat has vanished since John Deere invented the steel plow in 1837 and homesteaders headed West to stake claims and till the soil [see "Prairies: Rediscovering a Fragile Frontier," May/June 1999 *ZooGoer*]. Federally sponsored poisoning campaigns beginning in the early 1900s—and continuing today—further reduced prairie dog colonies, and ferret populations consequently plummeted. The black-footed ferret was listed as endangered in 1967, and no wild ferrets were seen between 1975 and 1980. The species was feared extinct.

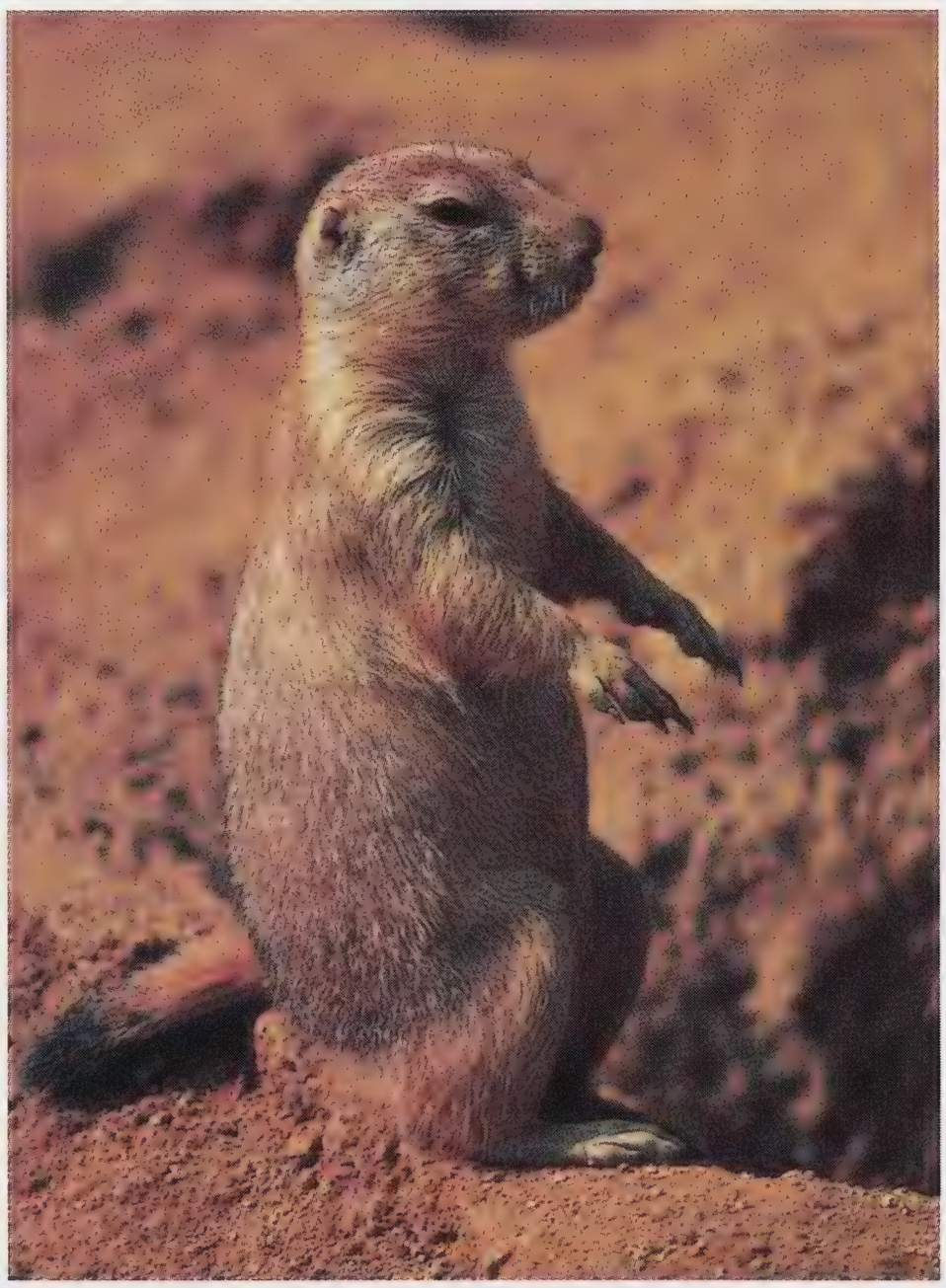
Then one crisp September night in 1981, Shep, a ranch dog in Meeteetse, Wyoming, killed a small animal he found at his food bowl. The dog's owners, Lucille and John Hogg, brought the unfamiliar creature to a local taxidermist, who recognized the masked bandit and promptly alerted wildlife officials. Biologists discovered a wild colony of black-footed ferrets nearby, and hope for the species soared.

But hope yielded to panic once again when flea-borne sylvatic plague struck the area's prairie dogs in 1984, and the population of about 130 ferrets went into a tailspin. Thirty-one ferrets were counted at Meeteetse in September 1985, and a mere 16 the next month. Only two male and two female ferrets survived the winter; yet, miraculously, each female gave birth to five kits the following summer. For the Wyoming Department of Game and Fish, it was now or never. Wildlife authorities had captured six ferrets the preceding year, and decided to trap the remaining individuals rather than risk another winter die-off. Eighteen ferrets now existed on the planet, none in the wild.

A Few Steps Back from the Brink

Seven ferret babies were born at Wyoming's Sybille Research Facility near Laramie in 1987, followed by 34 more in the summer of 1988. Yet a single fire or the outbreak of disease could deliver extinction instantly, so facility managers decided to split up the colony. Having shown success managing populations of clouded leopards, maned wolves, and other endangered species, the National Zoo's Conservation and Research Center became the first institution outside Sybille chosen to receive black-footed ferrets. In October 1988, seven ferrets arrived at the Front Royal, Virginia, facility.

Three generations removed from Wyoming, Bluebelle is the great-granddaughter of "Dean," one of the original 18 rescued from Meeteetse. As the total number of black-footed ferrets has blossomed through the breeding program to more than 500, scientists—including the National Zoo's Jon Ballou, a researcher specializing in small population biology—have had to monitor carefully the ferret family tree in order to preserve as much genetic variety as possible, and stave off the ill effects of inbreeding. The Zoo's Conservation and Research Center has played a unique role. Since 1995, CRC has focused on breeding reproductive "duds"—individuals with valuable, under-represented genes that haven't mated properly elsewhere. Breeding records maintained by the Black-Footed Ferret Species Survival Plan have shown that nearly half of male ferrets aren't fathering offspring through natural breeding, thus limiting the genetic variation in the population. Many male ferrets—perhaps befuddled by the opposite sex—display aggression to female partners, or can't figure out the proper positioning for mating. Every last ferret counts when extinction looms, and artificial insemination (AI) offers the last resort when sex the old-fashioned way fails.

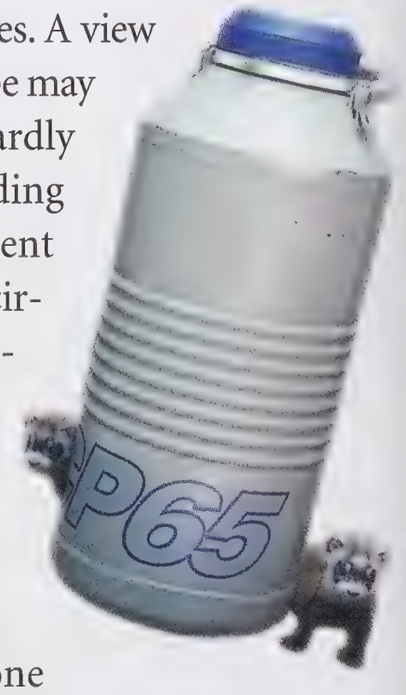


THE BLACK-TAILED PRAIRIE DOG, STAPLE OF THE FERRET DIET.

JoGayle Howard and her National Zoo colleagues first developed assisted-reproduction techniques for black-footed ferrets using domestic ferrets (*Mustela putorius*), and later Siberian polecats (*M. eversmanni*), their closest relatives, as models. Like Siberian polecats, black-footed ferret females display few visible signs of estrus, veiling the proper timing for AI procedures. Instead, the animal care staff at CRC have begun testing the readiness of female ferrets for ovulation by monitoring changes in their vaginal epithelial cells. When these cells demonstrate the readiness of the ovary's follicles to release an egg, veterinarians can administer a hormone to a female that stimulates ovulation. However, Howard discovered that the anesthesia necessary during AI procedures prevents sperm from being naturally transported through a ferret's reproductive tract. She therefore developed a surgical insemination technique using a laparoscope—essentially a miniature telescope that provides a view of a patient's internal anatomy—to guide sperm to a position near the ovary where fertilization could occur.

Scientists also rely on frozen sperm to broaden the range of individuals that can be paired through AI. National Zoo researchers, led by David Wildt, head of the Zoo's Department of Reproductive Sciences, have perfected cryopreservation techniques to store the semen of a variety of species, including clouded leopards, cheetahs, and giant pandas. Cheetahs at zoos across North America have now been impregnated by frozen semen collected from wild individuals in Africa (while Jomu, a cheetah at the National Zoo, was produced by artificial insemination using fresh semen).

Artificial insemination using both fresh and frozen sperm samples has produced more than 70 black-footed ferret kits at CRC since 1996, the first year the technique was implemented. The 70 to 80 percent rate of pregnancy from AI has even outpaced that of natural breeding (63 percent). Artificial reproduction has one particular advantage: Technicians can first screen sperm collected for AI in order to determine the most viable samples. A view through the microscope may expose upwardly mobile sperm gliding along, as well as bent sperm swimming in circles—like boats endlessly tacking—or ones with bent tails traveling hopelessly backwards. If no viable sperm have been produced, one sees only motionless blotches of skin cells, resembling craters on the moon. No signs of life.



ABOVE: THERMOS USED TO TRANSPORT FROZEN SPERM SAMPLES.

Poor semen quality, perhaps due to inbreeding, only partly explains the failure of many natural breeders to conceive. Research at CRC has shown that one-year-old ferret males, which actively mate with females, normally don't produce sperm until near the end of their first breeding season. Yet the act of breeding can induce ovulation, triggering a biological response known as "pseudopregnancy" in which female ferrets ovulate without conceiving and refuse to mate with other males—then actually begin building a nest. Ferrets breed during one short period each spring, so if a young male mates with a female, the female may lose her opportunity to bear offspring for an entire year. Fertility in female ferrets drops off dramatically after their third year of life, so the window of opportunity is narrow indeed.

Largely due to unsuitable suitors now being screened out, the number of births in ferret conservation facilities in 1998 jumped to 432, more than 20 percent above the previous year's record. CRC alone has witnessed the birth of 186 black-footed ferrets over the past 12 years. Insight into the secret world of ferret reproduction is thus helping CRC and other facilities maintain the species' genetic diversity, fortifying the ferret for a life back on the prairie.

"The glory of this place," says JoGayle Howard on a drive through CRC's vast campus in the Shenandoah foothills, "is you have a reproductive endocrinologist, people studying ecology and habitat, and experts in zoo breeding for animals that need help in all areas. You learn all you can about that species, and then go on to a new species. But you have to admit, the ferret is the cutest!"

The Native Returns

All along, the end goal of the ferret recovery program has been a secure future for wild ferret populations. By 1991, the number of ferrets in breeding programs was approaching 200, so conservation biologists at the U.S. Fish & Wildlife Service (USFWS) began preparing to reintroduce ferrets into the state from which the species was originally rescued. That year, a group of 49 ferrets scampered free into southeastern Wyoming's Shirley Basin.

Yet only a small proportion of the individuals first released survived from year to year. Brian Miller, now of the Denver Zoo, found that many ferret kits weren't accustomed to seeking shelter and safety underground. Teaching ferrets survival skills was the solution. An experiment by Dean Biggins of USFWS demonstrated that preconditioning ferrets to a life in the wild improved their odds of survival by 30 percent. Staff and volunteers at CRC therefore set about recreating life on the prairie for their resident ferrets.

Building a home for black-footed ferrets, in essence, means building a home for prairie dogs. First, workers haul a five-foot-high mound of dirt into outdoor preconditioning enclosures.

FERRET THEM OUT

Zoogoers hoping to sneak a peek at a black-footed ferret will find one living in the Zoo's Small Mammal House along Olmsted Walk. With FONZ support, the Zoo plans to add monitors at this exhibit with live video links of the black-tailed prairie dogs yipping away at the Zoo's American Prairie and the ferret kits being raised at CRC, as well as a video documenting National Zoo research on breeding, reproductive physiology, and reintroduction of black-footed ferrets. Expanded displays will further illuminate the ferret conservation story, Smithsonian research, and the contributions of the Black-Footed Ferret Recovery Program participants, including the U.S. Fish & Wildlife Service, state agencies, zoos, and Native American groups.

Children in CRC's region also have a unique opportunity to encounter a ferret face to face. CRC educators take a female ferret, Azusa, on the road to schools, primarily in the eight counties neighboring Front Royal, as well as to camps, summer school groups, and even juvenile detention centers. The first of its kind, the three-year-old Black-Footed Ferret Ambassador Program—developed by CRC education program manager Jennifer Buff—aims to teach kids the basics of small population biology and genetics, and specifically the challenge the ferret faces in recovering from near-extinction.

CRC became the first institution licensed to transport live black-footed ferrets for educational purposes. Six-year-old Azusa—well past her reproductive years—travels in a special "Ferret-mobile," a van adorned with a painted image of the masked creature. During presentations, kids can view, but not handle, the ferret inside her specially designed terrarium, then learn why this charming creature is so rare.

The black-footed ferret saga often surprises students. "Most of the animals they see when visiting zoos come from somewhere more exotic, yet this is one of the most critically endangered species—from right here in the U.S.," says Jennifer Shirk, education specialist at CRC. Jennifer Buff and Shirk take students through an hour-long program that includes an exercise investigating the effects of population crashes on genetic diversity. Kids receive colored beads which have passed through the long narrow bottleneck of a laboratory beaker. Students can then visualize which beads—or genetic traits—a species like the black-footed ferret can lose after a population bottleneck event. Buff is now developing a similar program to teach teachers and schoolchildren in South Africa about declining cheetah populations—one more example of CRC's global reach.

—Alex Hawes

BABY FERRET AT CRC.

GIANT STEPS

SHANTHI.

Ferrets aren't the only creatures having trouble mating the old-fashioned way. Shanthi, the Zoo's female Asian elephant (*Elephas maximus*), faces an obvious reproductive hurdle: no males. Bull elephants are dangerous, and most zoos lack the facilities to handle an adult male elephant. Transporting the four-and-a-half-ton female to a zoo that does house a bull has proven difficult and expensive. So Zoo scientists turned to artificial insemination (AI)—and the 24-year-old is now pregnant.

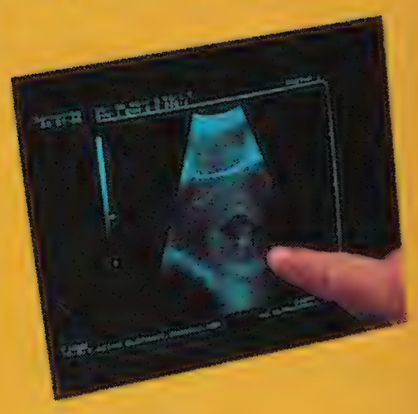
Shanthi's pregnancy is only the fifth successful artificial insemination of an elephant ever. For more than two decades, researchers had been attempting AI in elephants with no success. Then, in 1995, Janine Brown at the Smithsonian National Zoo's Conservation and Research Center (CRC) discovered a unique hormone pattern in the estrous cycle of female Asian elephants, just as German scientists Thomas Hildebrandt, Frank Goeritz, and Robert Hermes were developing an artificial insemination procedure using ultrasound technology and an endoscope-guided semen catheter. Scientists could now pinpoint the day of ovulation, then deposit sperm in exactly the right spot in the elephant's reproductive tract.

Shanthi became the first animal to receive the new procedure that year. The technique didn't work at first. The procedure was repeated several more times with the same result—no pregnancy. In the meantime, the first elephant calf conceived through assisted reproduction was born at the Indianapolis Zoo.

This year, the German scientists decided to try AI on Shanthi for a sixth and final time. Blood test results pointed to February 23 and 24 as her most fertile days. Three bull elephants had been chosen to provide semen samples, but only Calvin, a bull residing at the African Lion Safari in Canada, produced good quality sperm on each day. "It was very stressful," explained Brown, who coordinated the event. "We needed to get the sample and inseminate Shanthi on the same day." And so the sperm took to the air. It was collected from Calvin in the morning, then flown from Toronto to the Baltimore airport, where the sample was whisked to the waiting team at the National Zoo.

The AI procedure took nearly an hour, and was repeated the following day. By the third day, an ultrasound exam showed that Shanthi had already ovulated, rendering further inseminations unnecessary. For the next few months, Shanthi's blood was tested weekly to monitor progesterone levels. Then keepers noticed behavioral changes. "She was more expressive, more active. She wanted attention," explained Marie Galloway, head elephant keeper. By the third week in May, Shanthi's weekly blood test showed unusually high hormone levels. An ultrasound exam confirmed suspicions—Shanthi was pregnant.

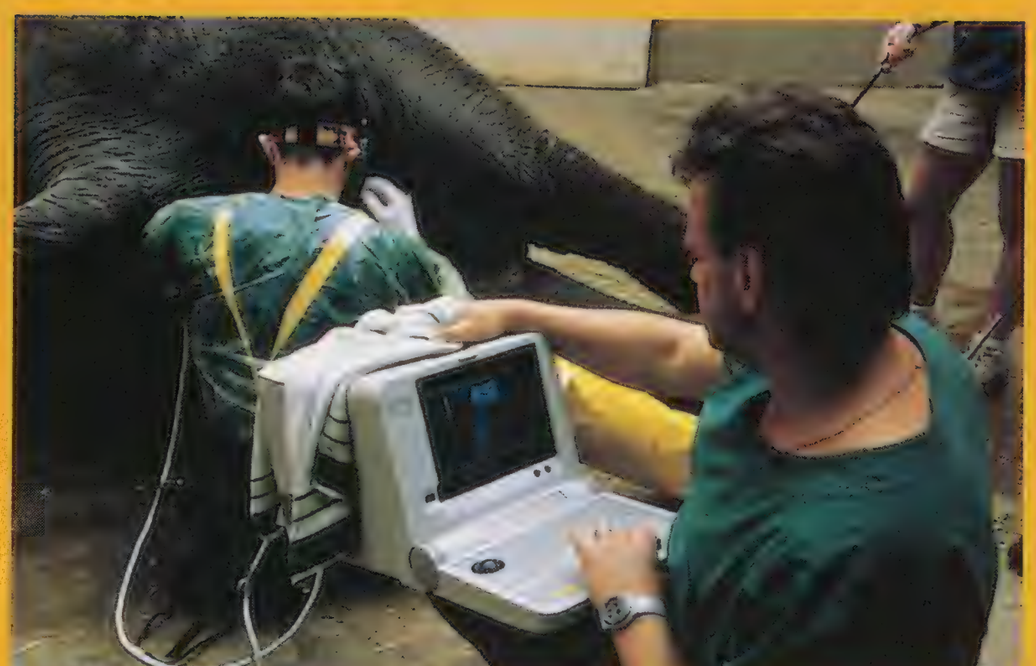
Elephants have a 22-month gestation—the longest of any mammal—so we can't expect the pitter patter of baby elephant feet anytime soon. Shanthi will be closely monitored over the next 14 months, with weekly blood screenings and observations. Her diet will include more nutrient-dense foods, and keepers will keep careful track of her weight. Six weeks before Shanthi's due date, researchers will begin to take daily blood samples. By plotting hormonal changes, researchers can predict delivery three or four days in advance, allowing time for everyone to prepare for the birthing process—and the new arrival.



Shanthi's first baby, Kumari, died 16 months after birth of a previously unknown herpesvirus. A team of scientists, led by National Zoo pathologists Richard Montali and Laura Richman, identified the virus as the one responsible for the deaths of other young Asian elephants in zoos. Scientists have since developed an effective treatment, using a drug called famciclovir, to save the lives of other baby elephants infected with the disease.

"Elephants in zoos may become as endangered as elephants in the wild," explains Brown. Fewer than five elephant calves are born in U.S. zoos each year, and if this trend continues, in 15 years there will not be enough calves born to replace older animals. "We're hoping that AI will become an additional tool for assisting in the breeding of elephants. Once it has become more routine, we can go to Asia or Africa and collect semen from wild bulls," says Brown. Using wild bull semen will contribute to the genetic diversity of the species. "AI is giving us hope."

—Laura Zajac



VETERINARY SURGEONS PERFORM AN ULTRASOUND, CONFIRMING THAT SHANTHI IS PREGNANT (SEE IMAGE OF FETUS: ABOVE, RIGHT).

PHOTOGRAPHY BY JESSIE COHEN/NZP

A FERRET FAMILY EXPLORES A PRECONDITIONING BURROW AT CRC.

LISA H. WARE

Then the prairie dogs are let loose. These master diggers immediately begin fashioning a burrow, and within weeks have developed an intricate maze of tunnels and below-ground chambers. Once their work is done, the prairie dogs are sent to construction duty elsewhere, and the burrow is ready for ferrets. From indoor enclosures in which they gave birth, ferret mothers can take their offspring through a door to the outdoor burrows once the kits have reached 45 days of age. Ferret families must occupy the burrows for several months before being ready to head West for reintroduction.

The more elaborate the burrow the better the enrichment, so burrows that have already been tunneled may need occasional "freshening up" by prairie dogs between stays by different black-footed ferret families. "It's like organized musical chairs," says Linwood Williamson, facilities manager for CRC. With ongoing burrow construction, 24 total enclosures will be available soon for preconditioning, enhancing CRC's capacity to prepare ferrets for a home back on the range.

Training for life in the trenches means learning about life in the food chain as well. Fifty days after birth, ferret kits and their moms receive live prey to teach them the hunting skills crucial for survival in the grasslands. At one point, CRC researchers even introduced their ferret cadets to "Robo-badger," a mechanical beast designed to instill fear of larger prairie predators like badgers and coyotes. Lampooned by one memorable Dave Barry column, the Robo-badger program was halted when the ferrets quickly saw through the guise and ignored the cybernetic predator's antics. Nonetheless, during preconditioning, CRC's ferrets soon spend most of the time below ground, only occasionally exploring the surface before returning to the safety of the soil. "That's what you want. Anytime there's a disturbance you want them to dive down into that hole," says Williamson.

The results of the program have been dramatic: Ferrets trained in preconditioning pens have displayed as much as a ten times greater chance of survival in the wild than those without any prior conditioning. Now all reintroduced ferrets must first complete prairie boot camp.

Ironically, conservation programs may be readying ferrets for reintroduction more quickly than land is available. In 1995, USFWS set a target of ten self-sustaining populations of 1,500 total ferrets by the year 2010. Today, seven sites exist in Wyoming, South Dakota, Montana, Arizona, and Utah—and Colorado will receive ferrets for the first time this fall. Only South Dakota's colony in the Buffalo Gap National Grasslands, however, is growing quickly. Not coincidentally, South Dakota contains the only ferret habitat free from sylvatic plague, a disease in prairie dogs with the same origins as the bubonic plague in humans. The plague can strike suddenly, as it did in Fort Belknap, Montana, in 1999, when a population of 153 ferrets plunged to only five after prairie dogs there contracted the disease.

Training for life in the trenches means learning about life in the food chain as well.

Ultimately, the ferret will survive in the wild only if large colonies of prairie dogs persist. A petition filed by the National Wildlife Federation in 1998 aims to list the black-tailed prairie dog (*Cynomys ludovicianus*) as a threatened species under the Endangered Species Act, a move that has temporarily halted poisoning on 3.8 million acres of prairie dog towns within U.S. Forest Service and Bureau of Land Management property. In January 2000, the USFWS ruled that this listing was warranted, but has delayed final ruling on the species' candidacy indefinitely due to more pressing needs.

Amid America's creeping suburban sprawl, finding large patches of healthy habitat for prairie dogs and their ferret dependents presents an even greater challenge. Indeed, the best site for future ferret releases may sit south of the border—in Mexico's Chihuahuan Desert, which boasts a vast black-tailed prairie dog colony that could support as many as 6,000 ferrets, researchers speculate.

Restoring ecosystems from sea to shining sea will itself speed the return of individual endangered species like the black-footed ferret. This fall, ten ferrets preconditioned at CRC will be transported to a new release site on the Cheyenne River Sioux Reservation near Eagle Butte, South Dakota. As one such ferret leaves the acclimation pen behind and darts across the grasslands, she will be greeted perhaps by the bobbing heads of a pair of burrowing owls, the coiled cringe of a startled prairie rattlesnake, the shadow of a soaring golden eagle briefly eclipsing the sun, or the yip of a prairie dog snapping from its buddha-like pose in the warm rays. Prepared for the moment, the ferret will dash to a nearby burrow, paw at the dirt to enlarge its entrance, and vanish silently into the womb of the earth.

Nature reborn at the dawn of the 21st century. Z

—Alex Hawes is Associate Editor of ZooGoer.

LISA H. WARE

BIO-ALMANAC

GOOD NEWS

Goats will eat anything. Aluminum cans, shoes . . . and dangerous, fire-feeding brush. Forest rangers across the nation are now using flocks of goats to clear thick brush in fire-prone areas of forest. While uncontrolled grazing by any animal—especially goats—can wreak havoc on the environment, targeted grazing can rid forests of low branches and brush that might otherwise fuel a fire. During a blaze, brush only three feet high can create a 15-foot firewall that sweeps through the forest at 15 miles per hour. Just a few days of controlled grazing can defoliate miles of dangerously high brush, thereby reducing the risk of a disastrous wildfire.

Goats also protect native flora and fauna by munching exotic weeds. Rather than spraying dangerous herbicides, rangers in Northern California send these hungry ungulates to remove unwanted plants from parks and land where the plants threaten native species.

Even sheep are getting into the act. A technique called "mob grazing" uses sheep, rather than smoke-spewing mowers, to trim grass under power lines. Controlled grazing is good news for all involved: Environmental groups are pleased, residents of fire-prone areas can sleep easier, and the goats and sheep get a good meal.

—*from* The New York Times *(6/13/00)*

BAD NEWS

Is it time to lather sunscreen on your maple tree? Maybe put shades on your pansies? A recent study found that plants can get sunburned. Researchers in Switzerland report that excessive ultraviolet radiation (UV-B) from the sun damages DNA in plants, and may even stunt their growth. Mutations accumulated in subsequent generations as the plants passed the DNA damage, or genetic rearrangements, to their offspring.

In humans, sunlight causes genetic damage to skin cells and can lead to tumor growth and skin cancer. Plants show the same kind of genetic damage, but do not develop tumors. While DNA rearrangements in themselves aren't necessarily bad—genetic mutations are nature's way of innovating—scientists fear that the depletion of the ozone layer could lead to a higher than normal mutation rate. Until researchers know the range and rate of mutations caused by UV-B, it is difficult to determine how serious the plant sunburn problem may be. So until then, leave the sunscreen and shades for humans.

—*from* Reuters *and* Planet Ark *(7/6/00)*

THE WILD WEB

Helping FONZ has never been easier. With a mere mouse click, web-savvy shoppers can buy products online at retail stores and contribute to FONZ—at no extra cost. Just click on GreaterGood.com through FONZ's website, select the store of your choice, do your shopping, and up to 15 percent of the proceeds will go to FONZ.

Other sites allow web surfers to preserve acres of rainforest or big cat habitat simply by visiting a site. The new webpage www.therainforestsite.com features a clickable button where visitors can choose to donate land—for free! The donations are paid for by The Rainforest Site's sponsors. Another site, bigcats.care2.com allows visitors to protect acres of endangered big cat habitat. Participants simply click on a photo of a tiger, jaguar, or snow leopard, and a donation is immediately sent to the Wildlife Conservation Society from one of the site's corporate sponsors. Donation size per click varies depending on the number of sponsors that day.

JESSIE COHEN/NZP

Similar sites include American Forests' Global ReLeaf program at www.webreleaf.com, and the choose-a-charity site, www.mysmallpart.com.

WHAT'S IN A NAME?

From the Kennedy Space Center and Hoover Dam, to Ronald Reagan Washington National Airport and Washington, D.C.—we've named all sorts of things after our presidents. Perhaps the most unusual example of a presidential namesake is *Felis leo roosevelti*, a subspecies of lion named in 1913 to honor Teddy Roosevelt.

Known as the conservation president, Roosevelt provided federal protection for nearly 230 million acres of American land. He was also an avid naturalist and big game hunter, spending time on safari in Africa collecting animals for American museums.

In 1904, Emperor Menelik of Abysinnia (now Ethiopia) presented Roosevelt with a gift: an adult male lion with a black-tipped mane. Thought to be a new subspecies, it was dubbed *Felis leo roosevelti* and brought here to the National Zoo, where it remained a popular attraction until its death in November 1906. The lion's body was then sent to the Smithsonian National Museum of Natural History, where it remains today. Though modern scientists no longer consider Roosevelt's lion to be a true subspecies—and the species' official name is now *Panthera leo*—our 26th president's name does still honor another famous "animal"—the teddy bear.

—*Laura Zajac*

GIANT PANDA
(Hsing-Hsing)

Ailuropoda melanoleuca

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BOOKS, NATURALLY

In addition to contributing numerous articles to scientific journals and edited volumes, CRC researchers have also written books for both a scientific audience and the lay reader. Here are a few titles.

Animal Talk.
Eugene S. Morton and Jake Page. 1992. Random House, New York. 265 pp., hardbound.
Animal Talk offers nonscientists a delightful glimpse into the world of animal communication. From the dance of bees to gorilla grammar, the authors offer entertaining anecdotes and discussion. Though out of print, this book can be found at your local public library.

Animal Vocal Communication: A New Approach.
Donald H. Owings and Eugene S. Morton. 1998. Cambridge University Press, New York. 284 pp., hardbound.
A "landmark text" on the study of animal communication, this book presents a new discussion of vocal communication in animals. In contrast to the typical notion of communication as information exchange, the authors describe it as the process of assessing other animals' behavior. This book was written for the scientific community, but an interested layperson will find it engaging.

The Ark Evolving: Zoos and Aquariums in Transition.
Edited by Christen M. Wemmer. 1995. The Conservation and Research Center, National Zoological Park, Smithsonian Institution, Front Royal, Virginia. 288 pp., softbound. $22.95.
This collection of essays covers current trends in the role of zoos and aquariums in science and conservation. It also explores the historical forces that shaped zoos and aquariums, as well as the public's changing perceptions of them. Available at the National Zoo Bookstore.

Birds of Texas: A Field Guide.
John H. Rappole and Gene W. Blacklock. 1994. Texas A&M University Press, College Station. 280 pp., softbound. $16.95.
A unique field guide that systematically describes the plumage, habits, voice, habitat, and range of birds in Texas. Each description is accompanied by a small map of Texas that is shaded according to the species range. Photos of each bird are in the appendix. Available by special order at the National Zoo Bookstore.

The Ecology of Migrant Birds.
John H. Rappole. 1995. The Smithsonian Institution, Washington, D.C. 270 pp., hardbound. $40.00.
Unlike the previous work, this book by the same author focuses on the wintering grounds of Neotropical migrant birds. Mainly a study of migration itself, it also touches on the ecology of the southern habitats and includes discussion of conservation. Available at the National Zoo Bookstore.

Lords of the Air.
Jake Page and Eugene S. Morton. 1989. Smithsonian Books, Washington, D.C. 288 pp., hardbound. $24.99.
Perfect for the lay reader, this fascinating glimpse into the world of birds is full of beautiful photos and illustrations. Chapters cover bird origins, migration, and communication as well as human enchantment with these feathered flyers.

Neotropical Migratory Birds: Natural History, Distribution, and Population Change.
Richard M. DeGraaf and John H. Rappole. 1995. Comstock Publishing Associates, Ithaca. 676 pp., softbound. $31.95.
This thick volume is full of information on Neotropical migrants—birds that breed in the U.S. and Canada, then fly south to Mexico, the Caribbean, or South America for the winter. The book includes a brief description of each species (including range, status, and habitat), range maps, and notes on species distribution and population change. Available at the National Zoo Bookstore.

The Science of Overabundance: Deer Ecology and Population Management.
Edited by William J. McShea, H. Brian Underwood, and John H. Rappole. 1997. Smithsonian Institution Press, Washington, D.C. 432 pp., hardbound. $39.95
This interesting and very relevant book is a compilation of essays on the overabundance of deer. Each essay represents a different perspective on the problem—from an animal welfare viewpoint to highly scientific surveys of deer populations in a specific region. Available at the National Zoo Bookstore.

—Laura Zajac

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